Appendix 8-A
Protecting Wetland Functions: An Overview of Considerations for Management

An important component of wetland protection and management is identifying what wetland functions need to be protected. Wetland functions can be grouped into three broad categories: water quality improvement, hydrologic functions, and habitat functions. Each of these can be further divided into more specific functions. For example, habitat functions can be divided into habitat for amphibians, habitat for mammals, etc. At the finest scale, we can consider the function of habitat for an individual species. (Chapter 2 in Volume 1 discusses the functions of wetlands in Washington State in detail.)

In addition to identifying what functions need to be protected, managing wetlands requires an understanding of how the functions are performed. Each wetland performs a function to a different degree based on a variety of factors. Some functions of wetlands are greatly affected by processes or influences that operate at large scales, while other functions are affected more by site-specific characteristics. Understanding how each function operates and how human activities can affect that function is critical to determining the appropriate type and level of protection that will be achieved through comprehensive plans, critical areas ordinances, and other regulations. (See Chapter 4 in Volume 1 for more information on how functions can be changed by human activities.)

In spite of the many differences in how wetlands function, one can generalize several approaches that will be effective in protecting each of the three groups of wetland functions (water quality improvement, hydrologic functions, and habitat functions). This appendix synthesizes the information available on what is needed to protect functions within a wetland or in its immediate vicinity, or to replace the functions if impacts are unavoidable. The discussion is organized by the three major groups of functions and by the different types of wetlands with special characteristics used in the *Washington State Wetlands Rating System*.

Wetland protection should encompass more than buffers and mitigation ratios

The most common method for protecting wetland functions has been the use of buffers. In addition, when impacts to wetlands have occurred, replacement of lost functions has typically been through setting ratios for compensatory mitigation that attempt to address the risk of mitigation failure and temporal loss of functions (see Chapters 5 and 6 in Volume 1).

Ecology has recommended standard buffers and ratios as part of the *Washington State Wetlands Rating System*. The first edition of the rating system relied on buffers and mitigation ratios to protect wetlands and maintain their functions and beneficial uses. Standards for buffers and ratios were recommended based on a wetland's category. Buffers were used as the tool for protecting the functions of a wetland, and mitigation ratios were used to ensure that the functions were adequately replaced if impacts could not be avoided.

The rating system was designed to characterize individual wetlands and their functions. Its focus is on the site itself. The guidance provided in this appendix reflects that bias and is focused on protection that can be provided in and around the wetland itself.

However, the review of recent scientific information has shown that this approach is overly simple and no longer reflects what we have learned about the complexity of wetlands and their functions. We have learned that protecting wetland functions cannot be achieved by using buffers and mitigation ratios as the only tools for protection. These measures by themselves will not completely protect many wetland functions from disturbances or replace the functions lost if impacts are unavoidable. Providing protection in the immediate vicinity of a wetland (e.g., buffers, use restrictions, etc.) will not always adequately protect wetland functions from disturbances that may occur elsewhere in the landscape. Other measures that take a larger, landscape approach and that utilize tools outside of the traditional regulatory realm may also need to be taken to fully protect wetland functions; these other measures are discussed elsewhere in Volume 2.

Protecting and Managing Habitat Functions

Wetlands provide habitat for a large number of species and play an integral part in maintaining the richness of species in the environment. Many different environmental factors affect the suitability of wetlands as habitat, the most important being the physical structure of the vegetation in the wetland, the water regime, and the condition of the vegetated and hydrologic connections between the wetland, uplands, and other aquatic resources. More detailed descriptions of how wetlands provide habitat are given in Volume 1.

The main question that arises when managing wetlands to maintain their capacity to provide habitat is: What species use the wetland and need protection? The recommendations made here are based on the assumption that wetlands with good structure and good connections to other habitats will provide habitat for a large range of species. In the absence of information on use, or lack of use, of an individual wetland by certain species, adequate protection needs to be provided that is based on the probability that the species are there. Wetlands that score highly for the habitat functions in the rating system have a higher probability of providing habitat than those with a low score. High scoring wetlands have the connections and structure to provide the habitat.

Buffers - The review of the literature indicates that there are several aspects of buffers that are important for wildlife. First, the width of buffers needed to protect habitat functions depends on the species needing protection. Some species using wetlands may need buffers in excess of 600 feet. Others, however, may need only 100 feet. In general, the information available indicates that buffers between 100 and 300 feet are adequate to protect most species found in wetlands in Washington.

Second, most studies on buffers have been done using buffers that were relatively undisturbed. It is difficult to extrapolate this information to judge the effectiveness of buffers that consist of lawns or tilled fields, or have otherwise been disturbed.

Third, the width of the buffer needed depends the type of disturbance the buffer is intended to reduce. Noise, light, or the movement of humans and pets may be reduced by providing a buffer of 100 feet. However, protecting the nesting and breeding of waterfowl generally requires a buffer of at least 200 to 300 feet depending on the type of disturbance.

Maintaining connectivity to other natural areas - The scientific information summarized in Volume 1 points out that fragmentation and the disruption of the vegetated corridors between undeveloped areas are a major cause of the loss of species richness (biodiversity). Existing connections and corridors to a wetland, as well as the structure within the wetland and its buffer, need to be preserved to protect the wetland's habitat functions.

Replacing habitat functions through compensatory mitigation - The loss of habitat functions is usually replaced by creating, restoring, or enhancing wetlands with the physical structure (vegetation, large woody debris, etc.) that provides ecological niches for different species. Studies of mitigation projects have shown that less attention is given to several other environmental factors that control the suitability of wetlands as habitat. These include the water regime needed to maintain the proposed habitat structure and the connectivity with other habitats that provides access for wildlife.

The studies of compensatory mitigation also indicate that high mitigation ratios alone will not guarantee that habitat functions will be adequately replaced. Chapter 6 of Volume 1 summarizes the many factors involved in determining whether a mitigation site is successful or not, and adequate ratios are only one factor.

At a minimum, a mitigation ratio should compensate for the loss of habitat during the time it takes the habitat structure to develop and the species to colonize the mitigation site (temporal loss of function). In the case of forested wetlands, this temporal loss is as high as 100 years or more, and as reported in Volume 1, no studies have found that all functions in a forested wetland have yet been reproduced through compensatory mitigation. Thus some functions cannot be replaced within a regulatory timeframe.

Protecting and Managing Water Quality Improvement Functions

Wetlands generally improve water quality by trapping pollutants (such as sediment) or by chemically transforming some pollutants into compounds that are no longer polluting (such as changing nitrates into nitrogen gas). The performance of the water quality functions by wetlands (removing sediment, removing nutrients, and removing toxic compounds) depends mostly on the structure of the vegetation that reduces water velocities and causes sediments and pollutants to settle, and on the chemical and biological properties of the soil in the wetland. More detailed descriptions of how these functions are performed are available in Volume 1. It is the geomorphic characteristics of the wetland and the physical structures found therein that control how a wetland improves water quality. Thus, a dense stand of invasive reed canarygrass can be just as effective at trapping pollutants as a dense stand of native sedges.

The issue in managing wetlands to maintain their capacity to improve water quality is: How much pollution is too much? Wetlands in watersheds where human activities pollute aquatic resources provide important functions by removing some of these pollutants. Large quantities of pollutants, however, can overwhelm the capacity of a wetland to improve water quality. For example, too much sediment entering a wetland can cover the organic soils that are important in trapping phosphorus and removing nitrogen.

The approach recommended for protecting wetlands at the scale of an individual site is to minimize the local input of any additional pollutants. The water quality functions that a wetland currently provides can be partially protected by limiting pollutants that would be added through a change to a more polluting land use (e.g., changing a forest to a residential development).

Buffers - Buffers trap pollutants and sediments before they reach the wetland. This helps to maintain the existing capability of a wetland for improving water quality. Protecting the water quality functions currently performed by a wetland would therefore require that any existing naturally vegetated buffers be protected from further degradation in the portion of the buffer that is most effective at trapping pollutants.

The review of existing literature in Volume 1 indicates that the effectiveness of buffers at trapping sediments and nutrients depends on many different factors, including the type of soils present, the type of vegetation present, and the slope. Furthermore the effectiveness is not linear. For example, a buffer of approximately 33 feet (10 m) will remove approximately 60% of the sediment and pollutants, while it takes a buffer of approximately 150 feet (50 m) to remove 75% or more of the sediment and pollutants, and a buffer of 660 feet (200 m) to remove 90% of the sediment and pollutants.

Reducing additional surface discharges of untreated runoff - Buffers will not adequately protect functions in a wetland if polluted waters bypass the buffer and enter the wetland directly via pipes, ditches, or other channels. To maintain the current levels at which a wetland improves water quality, it may be necessary to limit the introduction of any additional pollutants that might come in through untreated runoff that bypasses the buffer. It is assumed that no additional pollutants will be discharged if developers meet the requirements for treatment described in Ecology's stormwater manual.

Replacing functions that improve water quality through compensatory mitigation - The review of the information on mitigation found very few projects in which the replacement of the water quality functions was an objective. These functions have not been the focus of compensatory mitigation in the past. A study by Johnson et al. (2002), however, found that creation or restoration of wetlands generally resulted in the creation and restoration of the water quality functions to some degree. Enhancement, on the other hand, did not often improve the water quality functions of the wetlands enhanced and may even have reduced them. Over half of the enhanced sites that were evaluated in Washington State had minimal or no increase in the levels of the water quality functions.

If a wetland is created or restored, some of the water quality functions will tend to be established fairly quickly while others may take much longer. The temporal loss of functions incurred during compensatory mitigation is very dependent on site-specific conditions. The structural characteristics and water regime needed to perform the water quality functions can be established early, while the organic soils needed to more effectively trap phosphorus and remove nitrogen can take over 50 years to develop.

At a minimum, a mitigation ratio should compensate for the loss of the water quality functions during the time it takes build the mitigation site. The study by Johnson et al. (2002) found that the risks of replacing the water quality functions through restoration and creation are less than those for wildlife habitat. Therefore, replacing lost water quality functions may be possible through mitigation ratios that are lower than those for wildlife habitat functions.

Ratios for enhancement, however, may have to be high because most enhancement projects that call for revegetation of disturbed wetlands result in little, if any, increase in water quality functions. Many of the wetlands used for enhancement are degraded in terms of their habitat but actually perform water quality functions at a high level. It is not possible to increase their effectiveness at improving water quality to mitigate for the loss of these functions in the impacted wetland. For example, if enhancement increases the water quality functions by only 5%, a ratio of 20:1 (by area) is needed to compensate for the impacts.

Protecting and Maintaining Hydrologic Functions

Hydrologic functions provided by wetlands include reducing flooding, reducing erosive flows, and recharging groundwater. The performance of these functions depends mostly on the water storage available in the wetland, the density of vegetation that can reduce the velocity of flood waters, the permeability of the soils, and the distance from the wetland surface to groundwater. More detailed descriptions of how these functions are performed are available in Volume 1.

Buffers - The factors that control the hydrologic functions in a wetland are not significantly altered by changes in the buffer. The amount of water coming into a wetland, its velocity, and its timing are controlled by processes that occur at the larger scale of the watershed or basin. There is one case, however, in which buffers may help protect hydrologic functions. Buffers may protect the storage capacity of depressional wetlands by trapping sediments that might otherwise fill the wetland. In the absence of buffers that trap sediment, a wetland can slowly fill with sediment, reducing the amount of water it can store. In this case the requirements for a buffer would be similar to those for the water quality functions described above.

Replacing hydrologic functions through compensatory mitigation - The review of the information on compensatory mitigation found very few projects in which the replacement of hydrologic functions was an objective. The study by Johnson et al. (2002), however, found that creation or restoration of wetlands generally resulted in the creation and restoration of hydrologic functions to some degree. Enhancement, on the other hand, did not often improve the hydrologic functions of the wetlands enhanced. Approximately two-thirds of the enhanced sites that were evaluated had no increase in the levels of hydrologic functions.

If a wetland is created or restored, the hydrologic functions will tend to be established fairly quickly because they depend mostly on the physical structure of the wetland (e.g., storage capacity, permeability of soils). Compensation for impacts to these functions is more dependent on the structure and water regime of the mitigation site rather than the mitigation ratio.

Protecting and Managing Wetlands with Special Characteristics

Natural Heritage Wetlands (Freshwater)

Natural Heritage wetlands, as defined by the Natural Heritage Program of the Washington State Department of Natural Resources, contain rare plants or those that are particularly sensitive to disturbance. These types of species are very sensitive to nutrient enrichment (eutrophication) that results from the input of nutrient-rich waters. The greatest richness of plant species, especially rare species, is found in nutrient-poor wetlands. Rare plant species are outcompeted by large, regionally common species when excess nutrients are introduced to a wetland. Protection of Natural Heritage wetlands should focus on keeping nutrients out of these wetlands, maintaining the natural water regime, and reducing physical disturbance by humans (trampling, cutting vegetation, draining, etc.) within the wetlands.

Buffers - The buffer around a Natural Heritage wetland needs to be used to remove excess nutrients before they reach the wetland. The most efficient vegetated buffer, based on width-to-removal ratios, is about 60 m (197 feet) for removal of nitrogen and 75 m (253 feet) for phosphorus.

NOTE: A 250-foot buffer alone may not protect the rare or sensitive plants in the wetland if the watershed has high nutrient loadings or a water regime that is unstable.

Preventing new surface discharges to wetland or its tributaries - Buffers will not adequately protect rare plants in a wetland if polluted waters bypass the buffer and enter the wetland directly via pipes, ditches, or other channels. Furthermore, discharges of stormwater and changes in the water regime resulting from development will change the plant communities in a wetland (see review in Chapter 4 of Volume 1). Such changes might also impact the populations of the rare species in the wetland. Designs for treating stormwater do not reduce the nutrient loads significantly because they do not effectively remove nitrogen. To protect rare plants, it is necessary to limit the introduction of any additional nutrients that might come into the wetland through untreated runoff that bypasses the buffer.

Replacing Natural Heritage wetlands through compensatory mitigation - To our knowledge, there have been no successful mitigation projects that replaced the rare, threatened or endangered plant species found in a Natural Heritage wetland. Ecology and Fish and Wildlife assume that it is impossible to replace a Natural Heritage wetland through compensatory mitigation because the habitat required by rare and sensitive plant species cannot be reconstructed. The reconstruction of the habitat would require an extremely detailed understanding of the geological, biological, chemical, and physical requirements of each rare species found in the wetland. Such an understanding is not currently available in the existing scientific literature and would have to be developed through basic research.

Bogs

Bogs are also particularly sensitive to nutrient enrichment (eutrophication) because they have naturally low levels of nutrients. Bogs also often contain a high richness of plant species, especially rare ones, that are found only in such nutrient-poor wetlands. The rare plants in bogs, as in Natural Heritage wetlands, can be outcompeted by large, regionally common species when excess nutrients are introduced to a wetland.

Buffers - The buffer needs to be used to remove excess nutrients before they reach the bog. The most efficient vegetated buffer, based on width-to-removal ratios, is about 60 m (197 feet) for removal of nitrogen and 75 m (253 feet) for phosphorus.

Preventing new surface discharges to bog - Buffers will not adequately protect the functions of a bog if polluted waters bypass the buffer and enter the wetland via pipes, ditches, or other channels. To protect the bog it is necessary to limit the introduction of any additional nutrients and excess water that might come in through untreated runoff that bypasses the buffer.

Replacing bogs through compensatory mitigation - Bogs (and fens) are characterized by their highly organic soil conditions, unique water regimes, and water chemistries. Studies of bog and fen restoration in Northern Europe and Canada (reviewed in Volume 1) concluded that restoration may not be possible due to irreversible changes of the characteristics of a bog. No information was available on the success of bogs or fens that were restored or created as wetland compensation. However, the literature suggests that, even if it is possible to recreate the appropriate environmental conditions, bogs and fens cannot be reproduced within a regulatory timeframe. In Washington, Rigg (1958) reports that peat accumulates naturally in eastern Washington at a rate of 1 inch in 50 years. Ecology and Fish and Wildlife therefore assumes that it is not feasible to replace bogs through compensatory mitigation.

Forested Wetlands

Forested wetlands are given special consideration because they are difficult to replace through compensatory mitigation. The protection they need is based on the functions they provide. Buffers and other measures to protect the functions, therefore, should be determined based on how well the wetland performs these functions rather than on the presence of a forested community.

Replacing mature forested wetland through compensatory mitigation - Though the studies reviewed in Volume 1 have found that trees can be planted in Washington State wetlands and they will grow, mature forested wetlands have not been successfully reproduced simply because of the time necessary for the trees and the structural characteristics of the forest to mature. Enhanced and created sites that have been planted often have a high density of stems to rapidly provide woody cover and shade out invasive species in the understory. Unless these sites are thinned, they will not reproduce the attributes of mature forested wetlands.

Alkali Wetlands

Alkali wetlands are characterized by the occurrence of shallow saline water. These wetlands provide the primary habitat for several species of migrant shorebirds and are also heavily used by migrant waterfowl. They also have unique plants and animals that are not found anywhere else in eastern Washington. The salt concentrations in these wetlands have resulted from a relatively long-term process of groundwater surfacing and evaporating.

Buffers - The ecological process that maintains an alkali wetland is the dynamic between water inflow and evaporation. Buffers have little impact on maintaining this process.

The buffer needed for an alkali wetland should be based on the wetland's habitat functions. Alkali wetlands in eastern Washington are a major resource for migratory shorebirds and other water-dependent birds, and the buffers are needed to protect the shorebirds and waterfowl from disturbance.

Preventing new surface discharges - The routing of additional surface water to alkali wetlands will change the balance between inflow and evaporation. No information was found, however, on the impacts this may have on the ecosystem in the alkali wetland. There is a significant risk, therefore, that the ecosystem may be impacted if discharges into alkali wetlands are allowed.

Replacing alkali wetlands through compensatory mitigation - The salt concentrations in alkali wetlands have resulted from a relatively long-term process of groundwater surfacing and evaporating. These conditions cannot be easily reproduced through compensatory mitigation because the balance of salts, evaporation, and water inflows is hard to reproduce. No references were found suggesting that alkali wetlands have ever been created or restored. Until alkali wetlands have been successfully created, Ecology and Fish and Wildlife will view any proposed creation project as highly experimental.

Vernal Pools

Vernal pools in the scablands of eastern Washington are the first open water areas to melt in the early spring. This open water provides areas where migrating waterfowl can find food while other, larger bodies of water are still frozen. Furthermore, the open water provides areas for pair bonding of waterfowl. Thus, vernal pools are very important for migratory waterfowl during a short period in the early spring. The rest of the time the vernal pools provide little habitat for larger animals that need larger buffers.

Buffers - The review of the literature indicates that waterfowl need at least 200-foot buffers to protect them from disturbance. In a vernal pool that is currently undisturbed, such a buffer would protect the birds from disturbance while they feed and use the pool for courtship activities.

Replacing vernal pools through compensatory mitigation - Vernal pools are characterized by the short duration of their inundation. Thus, in order to reproduce a vernal pool, a site with a suitable substrate must be found and the correct depth and water regime must be created or restored. The literature suggests that, in California, vernal pools may be reproduced under the right conditions. No information was found on the reproducibility of vernal pools in Washington.

Wetlands in Estuaries and Coastal Lagoons

Wetlands in which the water has a salinity higher than 0.5 parts per thousand, are classified as "estuarine" or "coastal lagoons" for the purposes of rating them. Both types of wetlands are found along the coast and in river mouths.

Buffers - The ecological process that maintains estuarine wetlands and those in coastal lagoons is the dynamic between marine waters coming from the ocean and fresh waters coming from land. Buffers have little impact on maintaining this process. The buffer needed for both types of wetlands should be based on the wetlands' habitat functions. Estuarine wetlands and coastal lagoons are a major resource for migratory shorebirds and other water-dependent birds, and the buffers are needed to protect the shorebirds and waterfowl from disturbance.

Other protective measures - Estuaries and coastal lagoons have a high fish and wildlife density and species diversity, provide important breeding habitat, and serve as movement corridors (see Washington Department of Fish and Wildlife web page, http://wdfw.wa.gov/hab/phshabs.htm). Both types of wetlands are also a limiting habitat and are highly vulnerable to alteration. It is not possible to specify in advance what other approaches are needed to protect these types of wetlands because of the many different habitat functions they provide. Protecting the functions of these wetlands will require considering each wetland on a case-by-case basis.

Replacing wetlands in estuaries and coastal lagoons through compensatory mitigation - The main focus of this document has been freshwater wetlands. Information on mitigating impacts to estuaries and coastal lagoons was not compiled, so no recommendations can be made. Decisions about compensating for impacts to these types of wetlands will have to be made on a case-by-case basis.

Interdunal Wetlands

Interdunal wetlands form in the "deflation plains" and "swales" that are geomorphic features in areas of coastal dunes. These dune forms are the result of the interaction between sand, wind, water and plants. Interdunal wetlands provide critical habitat in this ecosystem (Wiedemann 1984), but no methods have been developed to characterize how well these wetlands function.

Buffers - Although we have little detailed information on how interdunal wetlands function as habitat, the information does show that these wetlands provide an important resource for many species. In the absence of more detailed information about the needs of species using interdunal wetlands, the buffers recommended are those for wetlands with a moderately high level of function as habitat. It is assumed that species using interdunal wetlands will need some protection from disturbance, but not the 300 feet needed by the more sensitive species. Interdunal wetlands are physically highly dynamic and exposed, and it is assumed that species using these wetlands do have some adaptations to disturbance.

Replacing interdunal wetlands through compensatory mitigation - One of the mitigation sites assessed by Johnson et al. (2002) was an interdunal wetland that was found to be moderately successful. Other, undocumented observations would also suggest that creating wetlands in the interdunal ecosystem is usually fairly successful (P. Lund, Department of Ecology, personal communications). As a result, the recommended ratios for creating these types of wetlands are lower than for other types.

The one stipulation, however, is that losses of interdunal wetlands should be compensated only by creating other interdunal wetlands. The interdunal ecosystem in Washington and elsewhere along the Pacific Coast covers a very limited area. Any further losses of this resource should be minimized.

References

Johnson, P., D.L. Mock, A. McMillan, L. Driscoll, and T. Hruby. 2002. *Washington State Wetland Mitigation Evaluation Study Phase 2: Evaluating Success.* Publication No. 02-06-009. Olympia, WA: Washington State Department of Ecology.

Rigg, G. B. 1958. *Peat Resources of Washington*. Bulletin No. 44 Division of Mines and Geology, State of Washington.

Wiedemann, A.M. 1984. *The Ecology of Pacific Northwest Coastal Sand Dunes: A Community Profile.* U.S. Fish and Wildlife Service FWS/OBS-84/04.